REMARKS

The Examiner Thanh T. Nguyen is thanked for carefully examining and reviewing the subject Patent Application. The Applicants appreciate the consideration given in the Response to Arguments Section; but, it has not changed and did not consider several new arguments presented. With entry of this response to the Office Action, claims 23 - 27 are considered to be in condition for allowance.

In an earlier office action, claims 1 - 22 were canceled by the Applicant, and non-elected claims 28 - 41 were withdrawn and canceled.

BACKGROUND OF THE INVENTION:

This invention relates to a method for reducing capacitance between closely spaced interconnection lines of integrated circuits. In particular, it pertains to a method for improving adhesion and preventing micro cracks in low dielectric constant materials when used in conjunction with conventional dielectric materials as inter-metal dielectrics (IMD). The Applicants discovered the above problem of micro cracking in low dielectric constant materials, when used in conjunction with conventional IMD layers. This problem was difficult to detect. Progress made in Silicon Technology has continued to shrink the size of devices. This has led to closer and closer spacing of interconnection lines. As spacing becomes closer, the capacitance between adjacent lines has increased, as device geometries shrink and circuit densities increase. The capacitance between lines is directly related to both the distance between the lines and dielectric constant of the material in between the lines. Hence, a low dielectric material between the closely spaced interconnect lines is beneficial in reducing the parasitic capacitance. Therefore, the introduction of low dielectric materials between the closely spaced interconnects and transmission lines, greatly

enhances the integrated circuit performance in terms of speed, by lowering the RC time constants.

The Applicants discovered that several problems arose using "conventional" methods, as shown in Applicant's prior art Fig. 1. One main problem discovered by the Applicants is the lack of adhesion of the cap oxide #8 to the underlying layer of low dielectric constant material #6. Other discoveries by the Applicants were problems with the introduction of reaction gases that include oxygen and nitrous oxide gases prior to a cap oxide deposition. These gases are necessary for reaction chamber stabilization and were found to react with the surface of the low dielectric constant layer, making adhesion of the subsequent cap oxide worse. The present invention solves these problems, as described in Applicant's claims 23 - 27, and outlined in Applicant's Figure 2a-d. The key solution to the various problems was the introduction of an adhesion promoter and stabilizing material, specifically a thin layer of silicon nitride, formed in between the low dielectric layer and the silicon oxide cap layer.

CLAIMS REJECTIONS - 35 USC 103:

Reconsideration of the rejection of Claims 23-25, and 27 under 35 U.S.C. 103(a), as being unpatentable over Jeng et al. (U.S. 6,114,186) in view of You et al. (U.S. 6,197,703) and Lucas (U.S. 6,287,951), is requested, based on the following.

There are patentable differences between the Prior Art cited and the Applicant's invention, namely the following. Note: There is a lack of direct comments about the main independent Claim 23.

The Applicant's curing conditions are not, as taught by Jeng:

" 300 ^{0}C by a hot plate bake ... ". Jeng (col. 4, lines 39-42);

Applicant's amended Claim 23, states low dielectric material curing at 400 ^{0}C.

Also, the Applicant states in amended Claim 23, that silicon nitride is both an adhesion promoter and stabilizing material, not taught by Jeng '186.

The Applicant's stabilizing material is not, as taught by Jeng:

"by plasmas with a thickness of about 1,000-3,000A" Jeng (col. 4, lines 42-60)

Jeng teaches layer #20, "cap layer", or dielectric layer preferably about 1,000 to 3,000 Angstroms in thickness, directly over the HSQ, low dielectric layer. This is a key patentable difference from that of the Applicant's disclosure of a thin silicon nitride adhesion promoter (~200-500 Angstroms in thickness) and stabilizer, directly over the low dielectric layer, formed in between the low dielectric layer and a thick 4,000 to 16,000 Angstrom in thickness oxide cap layer.

The Applicant's invention teaches the following stabilizing material:

The Applicant's dependent Claim 25 discloses that the method of independent Claim 23, for the layer of adhesion promoter and stabilizer is: a non-oxide compound.

"26. The method of claim 25, wherein said layer of adhesion promoter and stabilizer is silicon nitride, deposited by plasma enhanced chemical vapor deposition to a thickness of between about 200 and 500 Angstroms." (Claim 26 is relevant here.)

As stated above, the Applicant's invention teaches PE CVD, as the specific deposition method for the adhesion/stabilizer SiN layer, and the thickness range differs from the prior art. Therefore, the prior art neither teaches nor suggests the Applicant's method.

The Applicant's cap silicon oxide is not:
"cap silicon oxide layer (22) by PECVD with a thickness about 16,000 A".

The Applicant's invention teaches a cap silicon oxide:
Claim 27 depends on independent Claim 23, and states
",wherein said silicon oxide cap layer is deposited by plasma enhanced chemical vapor deposition, to a thickness of between about 4,000 to 16,000 Angstroms." This layer is deposited (Claim 23) "on the adhesion promoter and over the low dielectric constant material."

In sharp contrast, Jeng et al. teaches, in Col. 4 line 61, "The cap layer 20 may be followed by a thick, about 16,000 A, SiO_2, interlayer dielectric 22...".

Furthermore, Jeng's teachings have significant differences from that of the Applicant, ref. Jeng, Col. 4 lines 54 and 55,

"The thickness of the cap layer is preferably about 1,000 to 3,000 A, and most preferably about 2,000 A."

"You" ('703 B1, Col. 4, lines 8-19) teaches a method of forming by CVD a layer of "capping material" generally SiO, SiN, or SiON, over an HSQ layer.

Lucas et al. (U. S. Patent No. 6,287,951), primarily teaches forming a hardmask and an antireflective layer with silicon nitride, with a totally different application than that taught by the Applicant's claimed invention. The placement in the process for the "Lucas' nitride", is not to be used as a "stabilizer and adhesion promoter" on low dielectric material, as is taught by the Applicant's invention; thus, demonstrating patentable differences. The Lucas disclosure neither teaches nor suggests, the Applicant's claimed invention.

Reconsideration of the rejection of Claim 26 under 35 U.S.C. 103(a), as being unpatentable over Jeng et al. (U.S. 6,114,186) in view of You et al. (U.S. 6,197,703) and Lucas et al. (U. S. 6,287,951) as applied to claims 23-25, 27, further in view of Jeng et al (U.S 5,818,111) is requested, based on the following.

There seems to be no direct mention of "You, '703" above, on pages 5 and 6, in this section, Examiner's 12/28/2004 document.

There are patentable differences between the Prior Art cited and the Applicant's invention, namely the following. Note: There is a lack of direct comments about the main independent Claim 23.

Jeng ('186, '111) in view of Lucas, does not disclose the thickness of the SiN layer between 200-500 Angtroms, Applicant's Claim 26. Jeng ('186, '111) teaches the stabilizing layer #20 to be silicon dioxide, which is preferred for low-k silicate dielectrics. Jeng does teach that a SiN layer can be used as a stabilizing layer in certain applications; but, fails to teach that the silicon nitride layer can also be used as an adhesion promoter in Jeng '186 as well.

The Applicant teaches (Claim 25) that the layer of adhesion promoter and stabilizer is: a non-oxide compound. Furthermore, Applicant's Claim 26, dependent on Claim 25, "wherein said layer of adhesion promoter and stabilizer is silicon nitride, deposited by plasma enhanced chemical vapor deposition to a thickness of between about 200 and 500 Angstroms." This claim 26 is unique.

As stated above, the Applicant's invention teaches a non-oxide compound, deposited by PE CVD, as the specific deposition

method for the adhesion/stabilizer SiN layer, with a thickness range that differs from the prior art. Therefore, the prior art neither teaches nor suggests the Applicant's method.

A question of obviousness of the Applicant's claimed invention has been raised in connection with the prior art presented, and it is related to the use of nitride as a protection layer over HSQ. The material HSQ is never mentioned either in the Applicant's Specifications, or in the Applicant's Claims. Most of the Prior Art cited by the Examiner is concerned with processing HSQ material. These are patentable differences between what is taught by the prior art and what is taught by Applicant's Claims 23, 25 - 27.

As stated earlier, the Applicants have discovered that several problems arose using "conventional" methods, as shown in Applicant's prior art Fig. 1. One main problem discovered by the Applicants is the adhesion of the cap oxide #8 to the underlying layer of low dielectric constant material #6. Other discoveries by the Applicants were problems with the introduction of reaction gases that include oxygen and nitrous oxide gases prior to a cap oxide deposition. These gases are necessary for reaction chamber stabilization and were found to react with the surface of the low dielectric constant layer, making adhesion of the subsequent cap

oxide worse. The present invention solves these problems, as described in Applicant's claims 23 - 27, and outlined in Applicant's Figure 2a-d.

The above drawbacks were difficult to detect, but easy to solve using the Applicant's claimed invention method. Non-obviousness is established below, because the Applicant's discovered the following process problems, that were difficult to detect but easy solved and addressed by the Applicant's claimed invention. There was a lack of response to these arguments in Examiner's 12/28/2004 document.

CLOSING ARGUMENTS:

In conclusion, the Applicant's invention is believed to be patentable over prior art references of Jeng, Lucas, and You because there seems to insufficient basis for concluding that the modification of prior art disclosures to obtain the Applicant's invention, would have been obvious to one skilled in the art. That is to say, there must be something in the prior art or line of reasoning to suggest that the combination of several of these various references is desirable. We believe that there is no such basis for the combination.

The Examiner demonstrates a type of impermissible hindsight, by recognizing the advisability to combine the prior art references only after the Applicants have claimed the combination, as the motivation to combine the references.

Furthermore, at the time of the Claimed Invention, the Applicant's claimed invention was not "obvious to try", and the Applicant's claimed invention produces a synergistic result, that is greater than the sum of the parts, not found in Jeng, You, and Lucas.

The Applicants disagree with the Examiner, in that, we do not find present in the prior art, a good reason, suggestion or motivation for combining the teachings of Jeng, Lucas, and You to produce the Applicant's claimed invention.

In fact, the prior art references actually "teach away" from the Applicant's Claimed Invention, as demonstrated below: Jeng ('186, '111) in view of Lucas, does not disclose the thickness of the SiN layer between 200-500 Angtroms, Applicant's Claim 26. Jeng ('186, '111) teaches the stabilizing layer #20 to be silicon dioxide, which is preferred for low-k silicate dielectrics. Jeng does teach that a SiN layer can be used as a stabilizing layer in certain applications; but, fails to teach that the silicon nitride layer can also be used as an adhesion promoter as well. Jeng's cap layer thickness is different than the Applicant's. Lucas does not teach the SiN layer as a stabilizing layer. You teaches curing a HSQ layer, that is different than the Applicant's. Furthermore, the Applicant's SiN adhesion/stabilizing layer, coinciding with a low dielectric layer is not sketched the same in any of Lucas' figures.

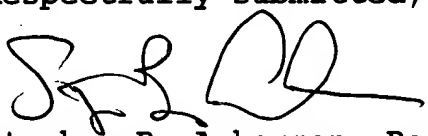
FINAL REMARK

The Examiner Thanh T. Nguyen is thanked again for carefully examining and reviewing the subject Patent Application. With entry of this response to the Office Action, all claims are now considered to be in condition for allowance.

All rejected claims 23 - 27 are now believed to be in allowable condition, and allowance is so requested.

It is requested that should there be any problems with this response to the Office Action, please call the undersigned Attorney at (845) 452-5863.

Respectfully submitted,



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